

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN OR RELATING TO MECHANICAL TRANSPORTERS AND AUTOMATIC TRANSPORT APPARATUS

(71) We, DAVID THEODORE NELSON WILLIAMSON and STANLEY VICTOR STARKEY, both British Subjects, and MOLINS MACHINE COMPANY LIMITED, a British Company, all of 2, Evelyn Street, Deptford, London, S.E.8, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention concerns improvements in or relating to mechanism having a load-carrying platform movable between a plurality of predetermined vertical positions. The platform may be that of a mechanical transporter for use, for example, in a machine tool installation as described in British Patent Specification No. 1,202,361.

According to the present invention there is provided a mechanism having a load-carrying platform movable between a plurality of predetermined vertical positions comprising, a plurality of parallel jacks having different strokes, each jack having an actuator rod extending therethrough movable in either direction, a rotatably mounted first sprocket carried by each end of each actuator rod, the sprockets being coplanar, a chain with stationary ends, the chain having an intermediate portion and two end portions, one end portion engaging each of sprockets at one end of the jacks by alternately passing around opposite sides of alternate sprockets in undulating fashion, the other end portion similarly engaging each of the sprockets at the other ends of the jacks such that upon actuation of a jack an undulation in one end portion is increased and the corresponding undulation in the other end portion is decreased and the intermediate portion is moved a distance equal to twice the stroke of the jack actuated, a vertically-spaced pair of second sprockets around which the intermediate portion of the chain passes, each second sprocket being driven by a shaft each of which also

carries a third sprocket, a first endless chain passing around the third sprockets, and a second endless chain which passes around a vertically spaced pair of fourth sprockets, one of the fourth sprockets being driven by bevel gearing and a cross shaft from one of the first-mentioned shafts, the platform being secured to corresponding runs of the first and second endless chains, whereby upon actuation in a predetermined direction of a predetermined selection of one or more of the jacks the intermediate portion of the chain causes the platform to move to the plurality of predetermined vertical positions.

Apparatus in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings in which:—

Figure 1 is a plan view of pallet-carrying mechanism in a transporter.

Figure 2 is a sectional view on the line II—II of Figure 1.

Figure 3 is a plan view of part of the mechanism shown in Figure 1.

Figure 4 is a sectional view on the line IV—IV of Figure 3.

Figure 5 is a side elevational view of pallet and tool magazine carrying mechanism in a transporter.

Figure 6 is a front elevational view of and through a transporter.

Figure 7 is a plan view of part of a transporter and a rack, and

Figure 8 is a diagrammatic representation, comprising seven views, of the transfer of pallets to and from a transporter.

The mechanism and devices described herein are also described in use in a machine tool installation in Patent Specification No. 1,202,361, and in the following description the mechanism and devices are described as used in such an installation.

A transporter 114 is shown in Figure 6 in front of a pallet rack 113 and a tool magazine rack 115. The pallet rack 113 has equispaced vertical partitions 635 carrying

horizontal angle irons 636 defining through compartments each of which can contain a pair of pallets in a horizontal position resting on the angle irons. The tool magazine rack 115 has similar vertical partitions 637, at the same spacing as the partitions 635, and supporting horizontal base plates 638 which define compartments each of which can contain a tool magazine in a vertical position. Mounted on the base plates 638 are guides 639, between which the sides of a tool magazine can pass, and rollers 640 arranged to run in sides grooves in the tool magazine.

Mounted on top of the pallet rack 113 and tool magazine rack 115 is a member providing rails 641 and 642 along which the transporter can run, by means of rollers (not shown) running between the rails. The transporter 114 is moved along the racks by means of an endless chain 251 connected to the transporter and passing round a sprocket (not shown) driven from a hydraulic motor.

The transporter 114 has a platform member 643 comprising two horizontal pallet-carrying platforms 644 and 645 and a vertical tool magazine carrier 646. Each of the platforms 644 and 645 is adapted to carry a pair of pallets in horizontal position, the pallet pairs being indicated as 647 and 648 respectively. The pallets are provided with identifying numbers and are transported in linked pairs as described in British Patent Specification No. 1,202,361. The carrier 646 is adapted to carry one tool magazine, indicated as 649, in a vertical position, and provided with an identifying number in the same way as the pallets. The platforms 644 and 645 are provided with guides 650, between which a pair of pallets can be received and held, and read heads 651 and 652 respectively, capable of reading the identifying number of a pair of pallets carried on the platform. The carrier 646 has guides 653, so that a tool magazine can be received and held between the guides and the carrier, and a read head 654 capable of reading the identifying number of a tool magazine being carried.

The platforms 644 and 645 are so spaced that when one is aligned with one vertical column of compartments in the pallet rack the other is aligned with the next but one column of compartments. Thus, as shown in Figure 6, the platform 644 is aligned with the column of compartments to the right of the partition 635a while the platform 645 is aligned with the column of compartments to the left of the partition 635b. By this spacing of the platforms a pair of pallets can, when required, be received from a compartment in one column on one platform while another pair of pallets is simultaneously delivered to

a compartment in the next but one column from the other platform.

To achieve accurate location of the transporter 114 relative to the columns of compartments in the pallet rack 113 and magazine rack 115, the transporter is provided, as shown in Figure 7, with hydraulically operated locators 655 and 656, consisting of nylon capped steel rods which can project from the transporter at 45° and locate against the partitions 635 or 637 of the racks. Preferably four such locators are provided so that two locate against each of two partitions, shown as 635a and 635b in Figure 7, near the top and the bottom of the partition. When the transporter comes to rest, as more fully described later, in approximately the required position relative to the racks, the locators 655 and 656 are hydraulically operated to project from the transporter and locate it accurately.

The platform member 643 can be moved vertically to align the platform 644 and 645 with any horizontal row of compartments in the pallet rack 113, or the carrier 646 with any horizontal row of compartments in the tool magazine rack 115, by mechanism shown in Figure 5. Each vertical column in the pallet and tool magazine racks contains eight compartments and therefore the member 643 must be capable of assuming any of eight vertically displaced positions. In Figure 5 the member 643 is shown in the lowest of these positions, i.e. at which the platforms 644 and 645 and the carrier 646 are aligned with the bottom row of compartments in the pallet and tool magazine racks respectively.

The platform member 643 is carried on an endless chain 660 passing round sprockets 661 and 662, and a further endless chain 663 passing round sprockets 664 and 665, by means of mountings 666 and 667 connecting the member 643 to the chains. The sprocket 662 is mounted on a shaft 668 carrying a bevel gear 669 which meshes with a bevel gear 670 on one end of a shaft 671. The other end of the shaft 671 carries a bevel gear 672 which meshes with a bevel gear 673 on a shaft 674 on which the sprocket 665 is mounted. By this drive connection movement of the chain 660 causes corresponding movement of the chain 663.

The sprocket 661 is mounted on a shaft 675 and the sprocket 664 on a shaft 676. The shaft 675 carries a further sprocket 677 and the shaft 668 carries a further sprocket 678. A chain 679, whose ends are attached to fixed parts 680 and 681, passes round the sprockets 677 and 678. Between the fixing 680 and the sprocket 677, the chain 679 passes round sprockets 682, 683 and 684, and between the sprocket 678 and the fixing 681 the chain 679 passes round sprockets 685, 686 and 687.

The sprockets 682 and 687 are respectively carried by brackets 688 and 689 attached to opposite ends of a rod 690 of a fixed hydraulic jack 691 having fluid inlets 692 and 693. The sprockets 683 and 686 are similarly carried by brackets 694 and 695 respectively attached to opposite ends of a rod 696 of a fixed hydraulic jack 697 having fluid inlets 698 and 699, and the sprockets 684 and 685 are respectively carried by brackets 700 and 701 attached to opposite ends of a rod 702 of a fixed hydraulic jack 703 having fluid inlets 704 and 705.

The stroke of the jack 703 is such as to move the platform member 643 by a distance corresponding to the vertical pitch of compartments in the pallet rack and tool magazine rack, for example to raise the member 643 from its lowermost position shown in Figure 5 so that the platform 644 and 645 and the carrier 646 align with the row of compartments next above the bottom row in the pallet and tool magazine racks respectively. Fluid under pressure admitted through the inlet 704 acts against a piston head on the rod 702 to lower the rod until the sprockets 684 and 685 occupy the positions indicated as 684a and 685a respectively. During this downward motion the sprocket 685 draws the chain 679 round the sprocket 678 while the sprocket 684 feeds out the chain 679 to travel round the sprocket 677, thereby rotating the shafts 663 and 675, and hence the sprockets 662 and 661, clockwise as viewed in Figure 5. Such rotation causes upward movement of the left hand vertical run of the chain 660, and of the right hand vertical run of the chain 663, thereby raising the platform member 643 by one pitch. The reverse operation by releasing the fluid pressure at the inlet 704 and applying fluid pressure at the inlet 705, raises the sprockets 684 and 685 back to their original positions, thereby lowering the member 643 by one pitch.

The stroke of the jack 691 is twice that of the jack 703 so that fluid pressure applied to the inlet 692 lowers the sprockets 682 and 687 to the positions indicated as 682a and 687a, thereby raising the platform member 643 by two pitches in the same manner as described above. Releasing the fluid pressure at the inlet 692 and applying pressure at the inlet 693 similarly lowers the member 643 by two pitches. By operation of both the jacks 703 and 691 the platform member 643 can thus be raised (and, on reverse operation, lowered) by three pitches.

The stroke of the jack 697 is four times that of the jack 703 so that application of fluid pressure to the inlet 699 raises the sprockets 683 and 686 to the positions 683a and 686a causing movement of the chains 660 and 663 to raise the platform member 643 by four pitches. On reversal, by releas-

ing pressure at the inlet 699 and applying pressure to the inlet 698, the member 643 is lowered by four pitches. Operation of the two jacks 697 and 703 thus moves the member 643 by five pitches, operation of the two jacks 697 and 691 moves the member 643 by six pitches, and operation of all three jacks 691, 697 and 703 moves the member 643 by seven pitches.

The platform member 643 can therefore be moved to occupy any of the eight positions at which the platforms 644 and 645 and the carrier 646 align with a row of compartments in the pallet and tool magazine racks respectively by appropriate operation of one or more of the jacks 691, 697 and 703.

The mechanism shown in Figure 5 is located at the left hand side of the transporter 114 as viewed in Figure 6, and the shafts 668 and 675 extend across the transporter, as shown, and carry further sprockets 706 and 708 respectively about which an endless chain 707, to which the platform member 643 is also attached, passes. The shafts 674 and 676 also extend across the transporter, in front of the shafts 668 and 675 as viewed in Figure 6, and carry further sprockets about which an endless chain attached to the member 643 passes. The shafts 668 and 675 respectively carry, towards their right hand as seen in Figure 6, sprockets 709 and 710 for a chain 711 fixed at its ends in a similar manner to the chain 679 and passing round sprockets mounted on a pneumatic counter or balancing jack (not shown) which serves to assist in maintaining the platform member at its required position achieved by appropriate operation of the jacks 691, 697 and 703.

It will be seen that either of the platforms 644 and 645, or the carrier 646, can be aligned with any desired compartment in the pallet or magazine rack respectively by appropriate horizontal movement of the transporter 114 along the racks to align the platform or carrier with the required vertical column of compartments, and appropriate vertical movement of the member 643 to align the platform or carrier with the desired compartment in that column. Similarly, either of the platforms 644 and 645, or the carrier 646, can be aligned with the pallet delivery position of a pallet loader or the tool magazine delivery position of a magazine loader respectively of any of a number of numerically controlled machine tools arranged in a line parallel to the pallet and magazine racks as described in British Patent Specification No. 1,202,361. The pallet and tool magazine delivery positions of the machine tool pallet and magazine loaders are located directly opposite vertical columns of compartments in the pallet and tool magazine rack so that the transporter can locate

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against the vertical partitions of the racks to align the platform or carrier with the delivery position.

Each of the platforms 644 and 645 has associated mechanism for drawing a pair of pallets on to or delivering a pair of pallets from the platform, the mechanism for the platform 644 being shown in Figures 1 to 4. Referring firstly to Figures 1 and 2 it comprises a pair of endless chains 712 extending along the platform, i.e. in the direction of travel of the pallets, and passing round sprockets 713 mounted on shafts 714 bearing driven sprockets 715 (Figure 1). Endless chains 716, passing round sprockets 717 on a shaft 718 driven by a hydraulic motor 719, pass round and drive the sprockets 715. The chains 712 pass round idler and tensioning sprockets 720, 721 and 722 and carry projecting pushers 723. The direction of drive is such that the pushers 723 move from left to right, as viewed in Figures 1 and 2, along the upper horizontal run of the chains 712. The pushers 723 can engage against the rear face of the trailing pallet 301 of a pair, and against the inner face of the front side of the leading pallet 302, the base of the pallets being recessed. The pallets are shown in full line in Figure 2 and broken line in Figure 1 and have projecting lugs 303—306 by means of which they can be linked as described in British Patent Specification No. 1,202,361.

To draw a pair of pallets to be received on the platform into the range of action of the pushers 723, and to effect final delivery of the pallets clear of the platform movable end members 724 and 725 are provided. These members have pivoted fingers 726 and 727 which can be raised to locate in the space between the end face of a pallet and the lug projecting therefrom, so that movement of the member 724 or 725 can effect movement of the linked pair of pallets.

The end member 725 is shown in detail in Figures 3 and 4, the end member 724 being the same as the member 725. The pivoted finger 727 is urged downwardly by a spring 728 and can be raised, to the position shown in broken line in Figure 4, by a hydraulically operated plunger 729 which engages against the finger. The plunger 729 projects through a hole in a disc 730 and carries a piston head 731 movable in a cylindrical chamber 732. When fluid under pressure is fed from a duct 734 and through an inlet 733 into the chamber 732 below the head 731 the plunger 729 rises, thereby raising the finger 727. When the pressure at the inlet 733 is released the finger 727, and hence the plunger 729, are lowered under the action of the spring 728.

The end member 724 is fixed to a slide rod 735 (Figure 1) bearing a piston head 736 movable along a cylinder 737 having an-

nular end chambers 738 and 739. Hydraulic pressure applied to the chamber 739 causes movement of the slide 735, and hence the member 724, to the left as viewed in Figure 1, and the slide 735 and member 724 can be returned, i.e. moved to the right, by releasing the pressure in the chamber 739 and applying fluid pressure to the chamber 738.

Alongside the cylinder 737 is a cylinder 740 which communicates through a port 741 with a bore 742 in a rod 743. The bore 742 communicates with the duct in the member 724 corresponding to the duct 734 in Figure 4, so that hydraulic pressure applied to the cylinder 740 can act through the port 741 and bore 742 to raise the finger 726. It will be noted that the port 741 remains in communication with the cylinder 740 throughout movement of the member 724 and rod 743 by operation of the slide rod 735. The right hand end, as viewed in Figure 1, of the rod 743, is accommodated by a bore 745 in a housing 744, in which the cylinders 737 and 740 are provided. A flexible and extendable connector 746 fits between the end member 724 and the housing member 744.

The right hand portion of the slide rod 735 is accommodated in a bore 747 in a slidable sleeve 748 having a piston head 749 movable along a cylinder 750. This cylinder has annular end chambers 751 and 752 and the sleeve 748 is integral with a rod 753 fixed to the end member 725. Thus fluid under pressure applied to the chamber 752 causes movement to the right of the sleeve 748, rod 753 and member 725. The sleeve, rod and member can be returned, i.e. moved to the left, by releasing the pressure in the chamber 752 and applying hydraulic pressure to the chamber 751.

Alongside the cylinder 750 is a cylinder 754 which communicates through a port 755 with a bore 756 in a rod 757 whose left hand portion is accommodated in a bore 758. The bore 756 connects with the duct 734 (Figure 4) so that the finger 727 can be raised by application of fluid pressure to the cylinder 754. Again, communication between the port 755 and the cylinder 754 is maintained throughout movement of the rod 757 and member 725 by operation of the slidable sleeve 748. A flexible and extendable connector 759 is provided between the end members 725 and the housing 744 in which the cylinders 750 and 754 are provided.

For a reason explained later the extent of movement of the slide rod 735, and hence the end member 724 is greater than that of the slidable sleeve 748 and end member 725, as can be seen by comparison of the lengths of the cylinders 737 and 750.

The platform 645 is provided with the same mechanism as described above in relation to the platform 644, except that the chains 712 are driven in the opposite direc-

tion, the drive mechanism comprising the motor 719, shaft 718, sprockets 717, chains 716 and driven sprockets 715 for the chains 712 in the platform 645 being located near the opposite end of the platform from the end near which the drive mechanism for the chains 712 in the platform 644 is located. By this arrangement pairs of pallets are received on the platform 644 from one side of the transporter 114 (the near side as viewed in Figure 6) and delivered therefrom at the opposite side, while pairs of pallets are received on the platform 645 from said opposite side of the transporter 114 (the far side as viewed in Figure 6) and delivered therefrom at said one side. Thus a pair of pallets transported from the pallet rack to a machine tool pallet loader is carried on the platform 645 and a pair of pallets transported from a pallet loader to the pallet rack is carried on the platform 644.

The operation of the transporter 114 will now be described with reference to Figure 8 which diagrammatically illustrates the transport of a pair of pallets from a compartment of the pallet rack 113 to a pallet loader 107—112. In this figure the end members associated with the platform 645 corresponding to the members 725 and 724 are indicated as 725a and 724a, and their fingers as 727a and 726a. The pallets of the pair are indicated as A and B.

When an on-line computer, as described in British Patent Specification No. 1,202,361, instructs the transporter 114 to collect the pair of pallets from their allocated compartment in the pallet rack, the hydraulic motor is started to drive the chains 251 and move the transporter along the racks 113 and 115 in the appropriate direction. At closely spaced intervals along the racks there are provided speed regulating devices (not shown) such as switches or photo-electric devices, which are effective to detect the position of the transporter along the racks at any time. The memory store of the computer includes information giving the required speed of the transporter as it passes the said devices while approaching its desired destination, and the devices are effective to regulate the speed of the motor so that the transporter acquires the required speed. The maximum speed of the transporter is about 10 feet per second and as it approaches its destination the speed regulating devices reduce its speed until it falls to about 1 inch per second, when the drive from the motor is cut off and the transporter comes to rest with the platform 645 in approximate alignment with the vertical column containing the compartment in which the pair of pallets is stored. When the transporter stops the locators 655 and 656 are hydraulically operated to project from and accurately locate the transporter with the

platform 645 aligned with the said column of compartments. The instruction from the computer giving the required compartment is also operative to actuate, if necessary, one or more of the jacks 691, 697 and 703 to raise or lower the platform member 643 so that the platform 645 is raised or lowered to align with the desired compartment in the said column.

On achieving such alignment the end member 725a is extended (by operation of the sleeve 742—Figure 1) to position itself beneath the projecting lug of the pallet A, and the finger 727a is raised (by fluid pressure applied to the cylinder 754—Figure 1) to engage between the lug and the side of the pallet, as shown in view (a) of Figure 8. The member 725a is then withdrawn, pulling the pair of pallets towards the platform 645 and as the leading side of the pallet 8 comes on to the upper run of the chains 712 their driving motor is started to move the chains so that pushers 723 engage against the inner face of the leading side of pallet A and can take over the drive of the pallets from the finger 727a (view (b)). The finger 727a is then lowered and the pallets are moved on to the platform 645 by the pushers 723 (view (c)) until both pallets A and B are completely on the platform (view (d)), when the drive to the chains 712 is stopped.

The read head 652 (Figure 6) can then read the identifying number of the pallets, indicating to the computer that they have been collected, and can continue to read their number while they remain on the platform. On receipt of the signal indicative that the pallets have been collected, locators 655 and 656 are withdrawn and the computer then instructs the transporter to move along the racks to align itself with the machine tool pallet loader from which the pallets are destined.

Normally the transporter is first instructed to align the platform 644 with the delivery position of the pallet loader, and to collect a pair of pallets waiting at that position, and then to align the platform 645 with the delivery position to deliver the pallets A and B.

On such alignment, achieved as explained above, the chains 712 are driven so that the pushers 723 push the pallets from the platform 645. The pushers 723 are so spaced along the chains 712 that pushers 723 can take over the drive of the pallets by engagement against the rear face of the pallet B as the front of pallet A leaves the chains (see view (d)), and the pallets are thus moved by the pushers 723 until the trailing end of pallet B leaves the upper run of the chains 712 (view (e)). The finger 726a of the member 724a is then raised to engage between the rear face of pallet B and its projecting lug, and the member 724a extended, by

movement of its slide 735a, to continue the drive of the pallets (view (f)) until they are clear of the platform 645 and on the paddle of the pallet loader (view (g)). The read head 652 then ceases to read the number of the pallets, indicating to the computer that they have been delivered. The finger 726a is then lowered and the member 724a withdrawn.

The transporter can then be moved to deliver the pair of pallets received on the platform 644 from the pallet loader to their allocated compartment in the pallet rack.

Movement of the end members 724a and 725a is effected in timed relationship with movement of the pushers 723 so that movement of the pallets is not interrupted as their drive is taken over by the pushers 723 from the finger 727a, or by the finger 726a from the pushers 723. The extent of movement of the member 724a is greater than that of the member 725a, as previously mentioned, because the transporter 114 is positioned closer to the pallet rack 113 than to the loading units 107-112.

The tool magazine carrier 646 is provided with tool magazine receiving and delivering mechanism essentially the same as that described in relation to the pallet carrying platforms 644 and 645, except that it has two endless chains 760 and 761 which are independently driven in opposite directions, and whose pushers, corresponding to the pushers 723, are retractable so that the pushers on one chain do not foul a tool magazine being moved by the other chain. When a change of tool magazine in a magazine loader of one of the machine tools is required, the transporter 114, on instruction from the computer is moved to align the empty carrier 646 with the magazine delivery position of the loader, and an end member, corresponding to the member 724, and the chain 760 are operated to draw the tool magazine from the paddle of the loader on to the carrier 646. The tool magazine number is then read by the read head 654 indicating receipt of the magazine to the computer. The transporter is then moved to align the carrier 646 with the allocated compartment of that magazine in the magazine rack 115, to which the magazine is delivered by operation of the chain 760 and an end member, corresponding to the member 725. On removal of the magazine from the carrier 646 the read head 654 ceases to read the magazine number indicating that it has been delivered. The transporter 114 is then moved to collect the newly required tool magazine from its allocated compartment in the magazine rack 115 and deliver it to the tool magazine loader, collection and delivery being effected by operation of the chain 761 and the end members.

The hydraulic operating devices for the

slides and end member fingers are housed in the transporter 114.

The transporter 114 is adapted to carry both pallets and tool magazines, but if it were to carry only pallets its platform member 643 would not need to have a tool magazine carrier 646 if the transporter is not required to transport tool magazines.

For the transport of bins, as described in British Patent Specification No. 1,202,361, there could be provided a bin transporter, generally similar to the transporter 114, but whose platform member corresponding to the member 643 provides a single horizontal platform adapted to carry one bin, having associated mechanism as described above in relation to the tool magazine carrier 646 for drawing a bin on to and delivering a bin from the platform at either side of the transporter. The bin transporter could run along rails on top of a bin rack, which is like the tool magazine rack having vertical partitions carrying horizontal base plates defining compartments each of which can contain one bin. A read head could be suitably located on the bin transporter to read the identifying number of a bin carried on the platform, and to signal to the computer the commencement and completion of a bin transport operation in the manner explained above.

In copending Application No. 21102/67 (Serial No. 1,225,975) there is described and claimed:—

A mechanical transporter movable horizontally and comprising support means for carrying an article, conveyor means operable to move an article in a horizontal direction along the support means, article engaging means to engage and effect movement of an article adjacent an end of the support means and outside the range of action of the conveyor means, and means to raise and lower the support means and the conveyor means and article engaging means, the article engaging means comprising a member movable towards and away from the end of the support means, and a retractable element mounted on the member and movable to project therefrom to engage an article and to be retracted to disengage from the article.

WHAT WE CLAIM IS:—

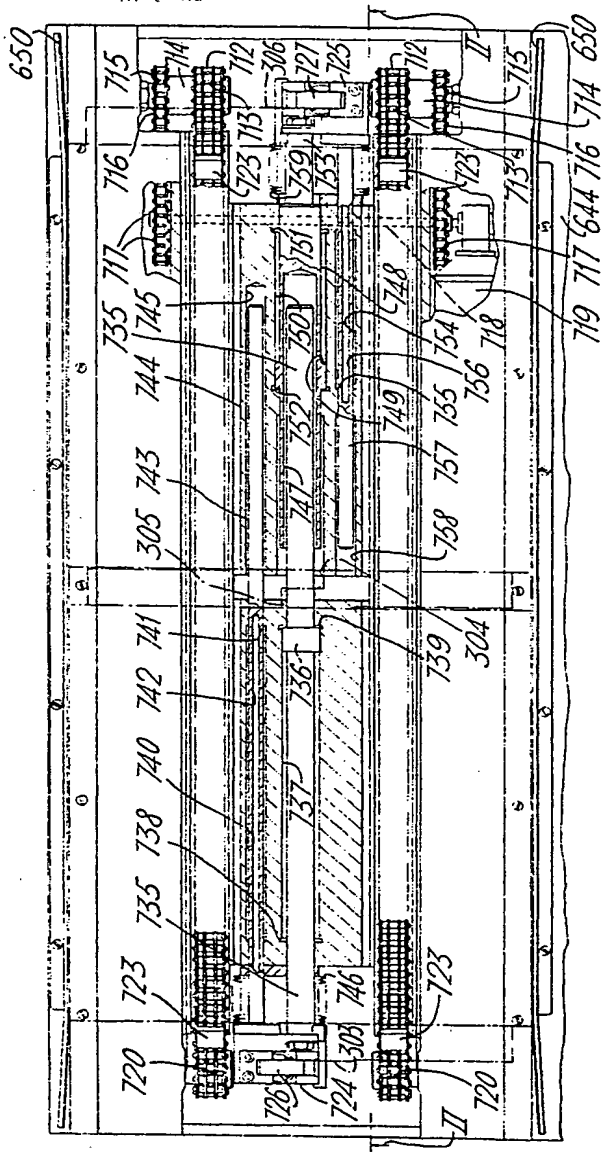
1. A mechanism having a load-carrying platform movable between a plurality of predetermined vertical positions comprising, a plurality of parallel jacks having different strokes, each jack having an actuator rod extending therethrough movable in either direction, a rotatably mounted first sprocket carried by each end of each actuator rod, the sprockets being coplanar, a chain with stationary ends, the chain having an intermediate portion and two end portions, one end portion engaging each of the sprockets at one end of the jacks by alternately passing

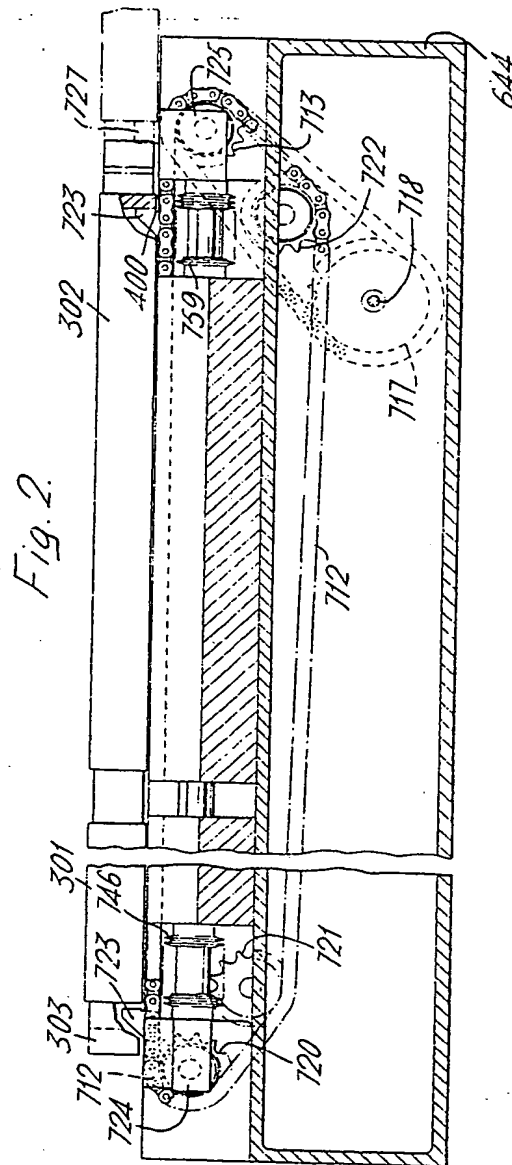
around opposite sides of alternate sprockets in undulating fashion, the other end portion similarly engaging each of the sprockets at the other ends of the packs such that upon
5 actuation of a jack an undulation in one end portion is increased and the corresponding undulation in the other end portion is decreased and the intermediate portion is moved a distance equal to twice the stroke
10 of the jack actuated, a vertically-spaced pair of second sprockets around which the intermediate portion of the chain passes, each second sprocket being drivingly carried by a shaft each of which also carries a third
15 sprocket, a first endless chain passing around the third sprockets, and a second endless chain which passes around a vertically spaced pair of fourth sprockets, one of the fourth sprockets being driven by bevel gearing and a cross shaft from one of the first-mentioned shafts, the platform being secured to corresponding runs of the first and second endless chains, whereby upon actuation in a predetermined direction of a predetermined selection of one or more of the jacks, the
20 intermediate portion of the chain causes the platform to move to the plurality of predetermined vertical positions. 25

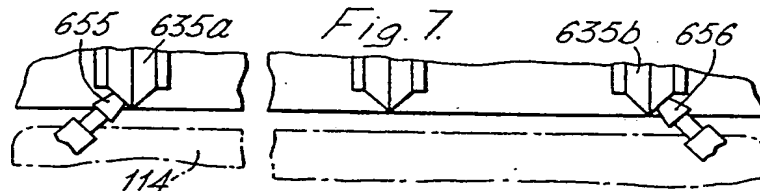
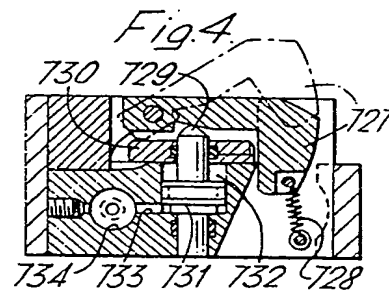
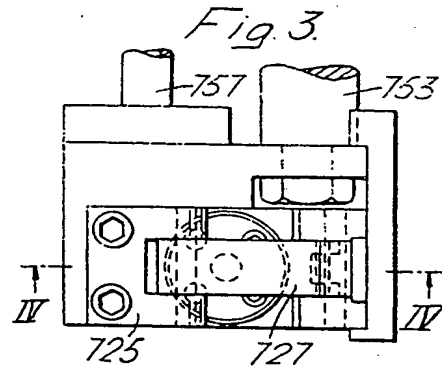
W. A. POWLEY,
Chartered Patent Agent,
2, Evelyn Street,
Deptford, London, S.E.8.
Agent for the Applicants.

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Fig. 1.







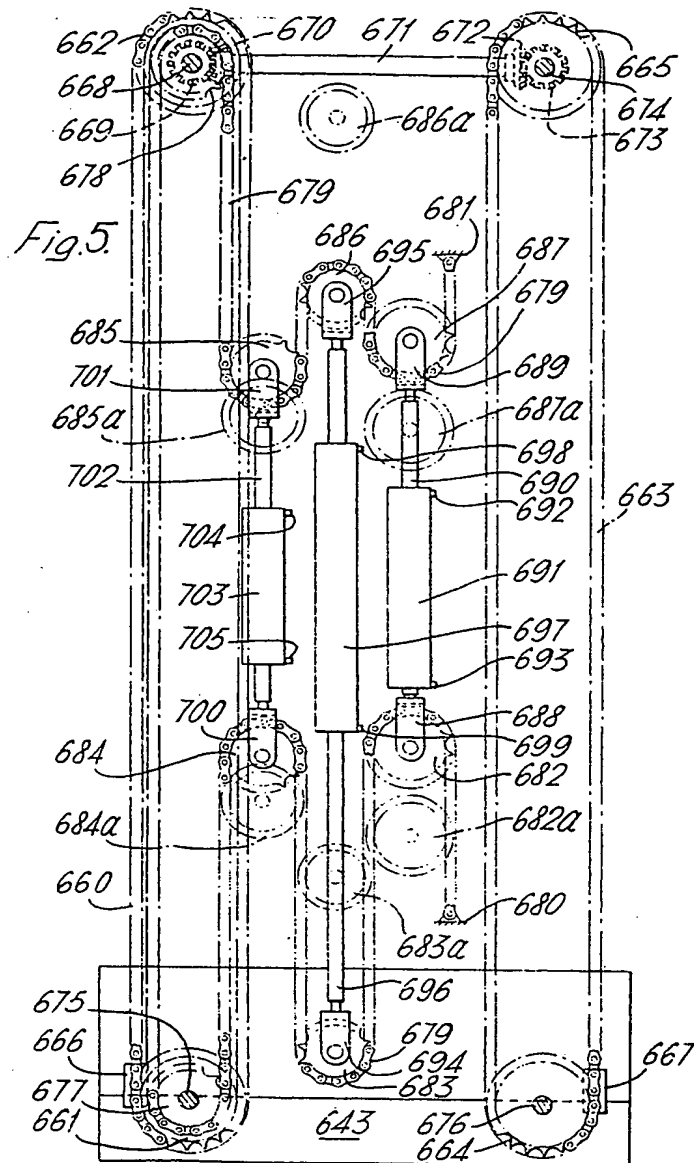
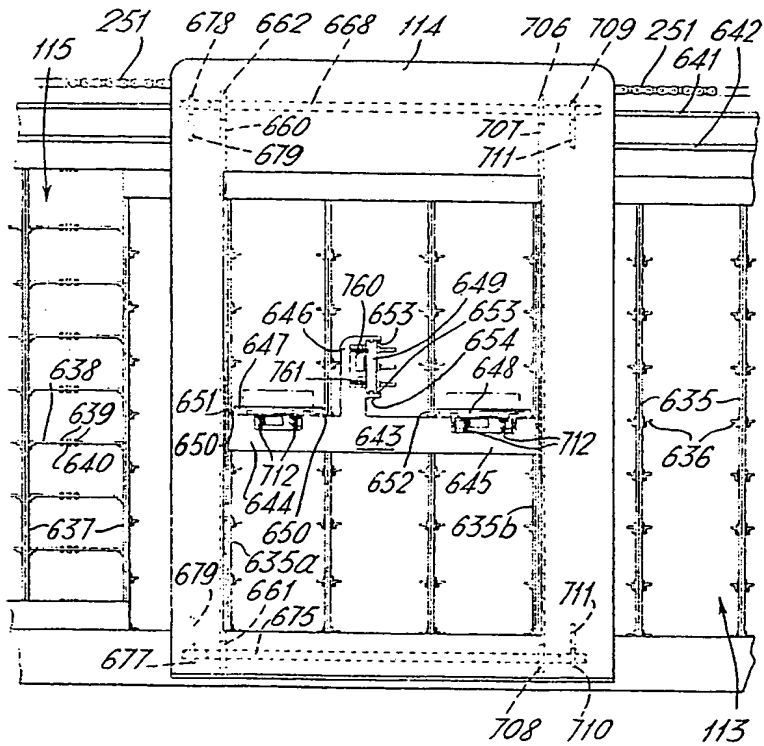
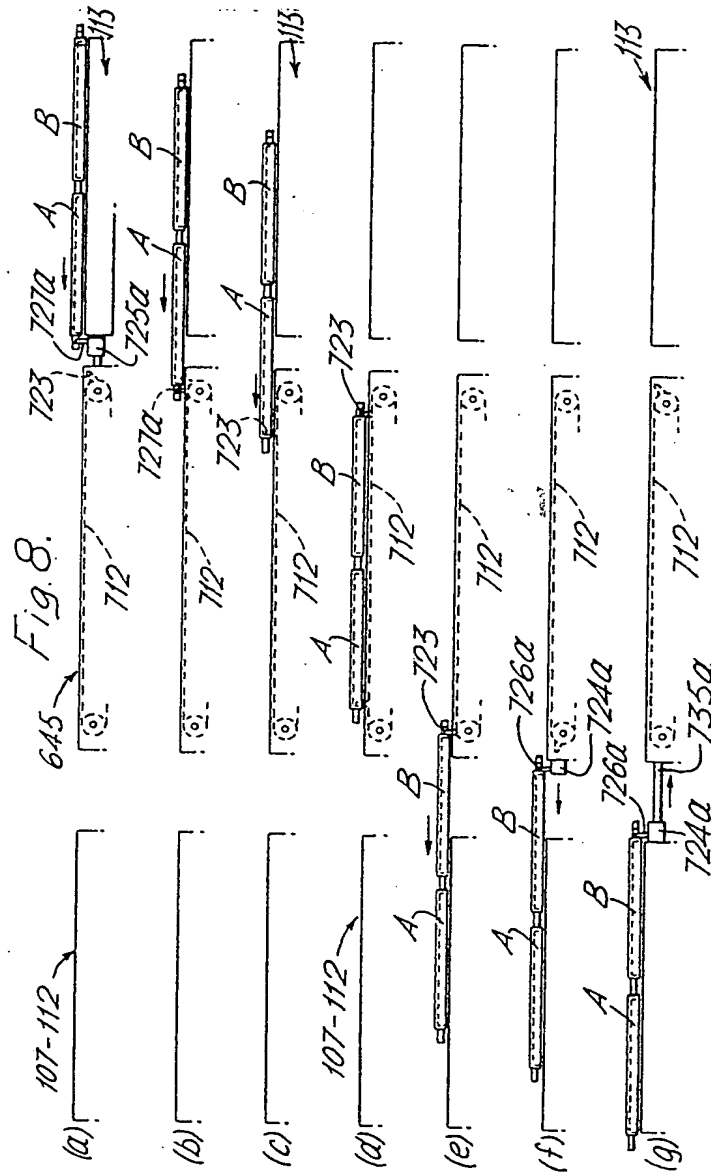


Fig. 6.





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